CHM129

Empirical and Molecular Formulas

Vanillin contains C, H, and O. When 1.050g of this substance is completely combusted, 2.43g of CO_2 and 0.50g of H_2O are produced. What is the empirical formula of vanillin? Its molar mass is 152.15g/mol. Find the empirical and molecular formulas.

mass of C: $2.43\text{ g } CO_2 \left(\frac{1\text{ mol } CO_2}{44.01\text{ g } CO_2}\right)\left(\frac{1\text{ mol C}}{1\text{ mol } CO_2}\right)\left(\frac{12.01\text{ g C}}{1\text{ mol C}}\right) = 0.663\text{ g C}$

mass of H: $0.50\text{g } H_2O \left(\frac{1\text{ mol } H_2O}{18.02\text{ g } H_2O}\right)\left(\frac{2\text{ mol H}}{1\text{ mol } H_2O}\right)\left(\frac{1.01\text{ g H}}{1\text{ mol H}}\right) = 0.056\text{ g H}$

mass of O: $1.050\text{ g Vanillin} - 0.663\text{ g C} - 0.056\text{ g H} = 0.331\text{ g O}$

$0.663\text{ g C}\left(\frac{1\text{ mol C}}{12.01\text{ g C}}\right) = 0.0552\text{ mol C}$

$0.056\text{ g H}\left(\frac{1\text{ mol H}}{1.01\text{ g H}}\right) = 0.055\text{ mol H}$ $\Rightarrow$ $C_{\frac{0.0552}{0.0207}} H_{\frac{0.055}{0.0207}} O_{\frac{0.0207}{0.0207}}$

$0.331\text{ g O}\left(\frac{1\text{ mol O}}{16.00\text{ g O}}\right) = 0.0207\text{ mol O}$

$(C_{2.67}H_{2.66}O) \times 3 \Rightarrow C_8H_8O_3$ Empirical Formula (MM: 152.16 g/mol)

$n = \frac{\text{MM molecule}}{\text{MM Emp. Formula}} = \frac{152.15\text{ g/mol}}{152.16\text{ g/mol}} = 1$

$(C_8H_8O_3) \times 1 \Rightarrow C_8H_8O_3$ Molecular Formula